# Technical efficiency and environmental management of hotels: The case of Sri Lanka

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Focusing on the efficiency evaluation of the hotel industry of Sri Lanka, this article attempts to diagnose the level and determinants of efficiency and provide insights for improvement. Sri Lanka, being a developing country undergoing a post war development stage, maximisation of efficiency is a challenging issue for individual hotels in the face of competition from major global players. We use Data envelopment analysis (DEA) double bootstrap approach to assess the technical efficiency and its determinants of a sample of medium and large scale hotels in Sri Lanka for the period 2010-2014. The results reveal that the average technical efficiency is 70.5% with the maximum being 96.4% and the minimum 43.6%. We find that age, size and type influence the efficiency levels of the hotels. Another key finding is that being environmentally responsible enhances the efficiency of hotels. The results of this study provide hotel operators and government with insights of competitive advantage and assist them with strategic decision making to improve the technical and environmental management of hotels.

## 1. Introduction

The hotel industry provides a significant contribution to the development of travel and tourism than any other broad category of tourism supply. Both internationally and locally, this industry has a relatively high economic impact from the boom in tourism in recent years. The hotel industry is complex, fragmented, highly competitive and greatly driven by globalization (Fyall & Garrod, 2005). Also it is known to be a very heterogeneous sector.

These characteristics make hotel industry an interesting study area with regard to tourism supply.

An efficiency analysis of the hotel industry not only contributes to the existing literature, but also the government and tourism stakeholders. Hotels come under great pressure to upgrade their efficiency relative to competitors, which implies the need for benchmarking analyses that can identify the best practices. At the micro level, the hotel industry is becoming increasingly sensitive to the changing tastes and preferences of tourists seeking accommodation (Assaf & Agbola, 2011). Efficiency is an important consideration for hotel managers whose goal is to boost profitability (Shang, Wang, & Hung, 2009). Moreover, efficiency evaluation is beneficial for policy makers to provide guidelines to correct inefficient management directions and to promote positive effects from competition.

The tourism industry today faces new constraints including environmental degradation which represents a central concern for governments and stakeholders (Hathroubi, Peypoch, & Robinot, 2014). In recognition of the negative environmental impacts of production, governments, along with the green movement within the hotel and tourism industry, and travellers, have become increasingly aware of the need for more effective measures to protect the environment. Several studies find that consumers increasingly prefer and appreciate hotels which address environmental concerns (Bohdanowicz, 2006; Chan & Wong, 2006; Hathroubi, et al., 2014). In this context, the hotel managers must recognise the need to adopt strategies that incorporate environmental sustainability.

Government regulations (such as for the environment) generally come in place in order to regulate firm behaviours for environmental benefits. In a given socio economic and a policy environment such as in a developing country situation, adopting eco-friendly practices (green practices) may involve expensive inputs. As a result certain hotels tend to use environmentally detrimental inputs. For example, installation of efficient HVAC (heating, ventilation, air conditioning) systems, energy efficient lighting (LEDs and CFLs) and renewable energy sources involve greater initial costs. During introduction stage of the concept of a green hotel, hoteliers pay more efforts to make their operations eco-friendly, thereby impacting cost efficiency (Shieh 2012). Nevertheless, studies conducted by the International Hotels Environment Initiative (IHEI) reveal that 90% of hotel guests prefer to stay in a hotel that cares for the environment.  Therefore, in the long run environmental efforts can help hotels save money, improve their competitiveness and attract environmentally concerned consumers. Government efforts to promote environmentally friendly practices in firms should be highly appreciated not only to improve the competitiveness of firms but also to avoid negative environmental impacts.

Such considerations are particularly important in developing countries such as Sri Lanka where tourism industry is considered as one of the fastest growing sectors in a post war development stage. Tourism is the fourth largest foreign exchange earner and contributes significantly to the economic growth and development of the country. For nearly 30 years until 2009, the average annual occupancy rate in graded accommodation was below 60% due to war and civil unrest. However it has dramatically increased from 48.4% to more than 71% by 2012 due to the post-war tourism boom. These data suggest positive developments and additionally the Sri Lankan government increasingly encourage hotels to address environmental issues to move to a sustainable development position. However, after adopting eco-friendly practices in their organisations, hotel managers as well as the government need to benchmark how these strategies might improve their efficiency.

Consequently, this paper aim to show how environmentally friendly practices may enhance the technical efficiency of hotels. The objective is twofold. First it measures the technical efficiency of a sample of medium and large scale Sri Lankan hotels and second, evaluates the impact of eco-friendly practices on efficiency.

This research paper proceeds as follows. Section 2 provides the context setting and in section 3, we review related prior studies in the areas of efficiency in the hotel industry. Section 4 proposes the research method. Section 5 provides the data description, empirical results and interpretations. Finally, section 6 summarises concluding remarks.

## 2. Contextual setting: the importance of tourism industry in Sri Lanka

Sri Lanka, a tropical island country in South Asia, and is well known as an authentic tourist destination for its environmental diversity and cultural heritage. Since the end of the civil war in 2009, tourist arrivals in the country have been increasing and have been recognised by policy decision-makers as the sector with the highest growth potential in the post war development scenario. In 2012, 1 million foreign tourists visited Sri Lanka and the projected growth is 2.5 million by 2016. In terms of accommodating the large projected numbers of tourist arrivals, the supply side firms such as hotels have a vital role to play in the economy.

For example in 2014 tourism contributed 9.4% of Sri Lanka’s gross domestic product (GDP) and contributed to 8.4% of total employment (World Travel and Tourism Council, 2014). According to Sri Lanka Tourism Development Authority (SLTDA) statistics, there are over 200 tourist accommodation units categorised as boutique villas and hotels, guesthouses and tourist hotels which are of international standards of operation. Over 1 million tourists arrive in Sri Lanka each year to accommodate these units. To cater to this rapidly rising tourism demand, maximization of efficiency hence becomes fundamental especially for the hotel industry. Moreover, with rising competition from the Asian market, Sri Lankan hotels can only remain competitive by being efficient.

Despite the importance of this industry to the Sri Lankan economy, its future is threatened by the emergence of competitors in the global as well as in the Asian market on a large scale. Currently, the industry is facing the following problems. Firstly, there is an increasing number of emerging Asia Pacific tourism destinations such as Vietnam, Philippines and Mongolia with a competitive advantage in price (Leung & Baloglu, 2013). Secondly, there has been inadequate public policy in Sri Lanka over the last few years on hotel operation to best suit the needs of the tourism industry. Thirdly, there is no proper strategy to improve the efficiency of the industry to be able to gain the competitive advantage in the international market.

The hotel industry faces new constraints such as environmental degradation which is a major concern for tourism (Erdogan & Tosun, 2009). Many hotels have realised that 'going green' is not only good ethically but that it is also beneficial in reducing cost and creating market differentiation. A solid platform has been laid by both the Sri Lankan government and hoteliers in an attempt make the tourism industry more environmentally sustainable. Programmes such as "Greening Sri Lankan Hotels" focuses on small and medium scale (SME) hospitality enterprises in particular, and the hospitality industrialists in general, with a supporting role of enhancing knowhow on improving energy and water utilization efficiencies. The Sri Lankan hotel industry can achieve savings of 20% in energy and water consumption, and there is a possibility of reducing waste generation by 20% (EU SWITCH-

Asia, 2013). Therefore adopting green practices appears to be an attractive and profitable option for hotels.

## 3. Literature review

Studies on hotel performance evaluation is increasingly catching the attention of researchers who have attempt to appropriately measure the efficiency of hotel industry operations in order to provide insights to hotel industry in general and hotel managers in particular with desirable information for effective decision making. Efficiency is an important consideration for hotel managers because they first look at efficiency to boost profitability (Shang, et al., 2009).

Studies on efficiency of hotel industry have been attempted by several researchers and of recent there are a number of studies addressing efficiency of hotels in a number of contexts. The two main methods that have been used to estimate efficiency of hotels include data envelopment analysis (DEA) and stochastic frontier approach (SFA)[1]. We exhibit in table 1 a summary of studies which uses DEA to measure efficiency of hotels. DEA is first applied in the hotel industry studies by Morey and Dittman in 1995 to measure performance of 54 US hotels. Since then, hotel efficiency literature extensively use CCR and BCC models. Hwang and Chang (2003) use DEA CCR model to measure the managerial performance of 45 hotels in Taiwan. Anderson, Fok, and Scott (2000) utilise both BCC and CCR models to analyse the performance of 48 US hotels in 1994 and finds that the overall efficiency value was a mere 42% due to poor technical efficiency and scale efficiency. Other studies which use BCC and CCR models include Tsaur (2001), Brown and Ragsdale (2002), Reynolds (2003), Chiang,

[1] This paper focuses only on the DEA literature in hotel efficiency

Tsai, and Wang (2004) and Barros (2005a). Although such studies exist, none actually tackles the efficiency of the hotel industry in the Sri Lankan context.

Moreover, most existing efficiency studies of the hotel industry fail to account for the impact of environmental variables on efficiency. The environmental variables could have an influence the efficiency of a firm, where such factors are not traditional inputs and assumed not under the control of the firm (Coelli, Prasada Rao, O'Donnell, & Battese, 1998). Ignoring such factors thus does not give accurate results. Barros and Dieke (2008) test the impact of ownership (chain or independent hotels) on efficiency and find that hotel's membership in a group increases efficiency. Assaf, Barros, and Josiassen (2010) find that size, ownership and classification of a particular hotel have a significant impact on its efficiency. Shang, et al. (2009) measure the impact of hotel management factors (i.e. location, age and management style) on efficiency.

**Table 1: Literature survey of DEA models on tourism**

| Study | Method | Units | Inputs | Outputs |
|---|---|---|---|---|
| (Morey & Dittman, 1995) | DEA | 54 US hotels | (1) Room expenditures; (2) energy costs, (3) salary; (4) advertising expenditures; (5) non-salary expenses; (6) fixed expenditures. | (1) Total revenue; (2) level of service delivered; (3) rate of growth. |
| (Anderson, et al., 2000) | DEA (technical and allocative) | 48 US hotels | (1) Fulltime equivalent employees; (2) number of rooms; (3) total gaming related expenses; (4) total food and beverage; expenses; (5) other expenses. | (1) Total revenues; (2) other revenues. |
| (Tsaur, 2001) | DEA | 53 Taiwanese hotels | (1) Total operating expenses; (2) number of rooms occupied; (3)Total floor space; (4) Number of employees in the catering division; (5) Catering costs. | (1) Total operating revenues; (2) number of rooms; (3) average daily rate; (3) total operating revenue of the catering |

| | | | | |
|---|---|---|---|---|
| | | | | division |
| (Hwang & Chang, 2003) | DEA CCR model; super-efficiency model; Malmquist | 45 Taiwanese hotels | (1) Number of fulltime employees; (2) number of guestrooms; (3) total dimension of meal department; (4) operating expenses. | (1) Room revenue; (2) food and beverage revenue; (3) other revenue. |
| (Barros, 2005a) | DEA Malmquist with second-stage Tobit regression | 42 Portuguese hotels (1999-2001) | (1) Full-time employees; (2) cost of labour; (3) Book value of property; (4) Operating costs. | (1) Sales; (2) number of guests; (3) number of nights occupied. |
| (Barros, 2005b) | DEA-CCR and DEA-BCC model | 42 Enatur hotels in Portugal | (1) Full-time employees; (2) cost of labour; (3) rooms; (4) surface area of the hotel; (5) book value of property; (6) operational costs; (7) external costs. | (1) Sales; (2) number of guests; (3) nights spent. |
| (Barros & Santos, 2006) | DEA allocative model | 15 Portuguese hotels (1998-2002) | (1) Full-time employees; (2) book value of assets | (1) Sales; (2) added value; (3) earnings. |
| (Barros & Dieke, 2008) | DEA 1st stage Malmquist with 2nd stage bootstrapped Tobit model | 12 Luanda-African hotels | (1) Total cost; (2) investment expenditure | (1) Revenue per available room |
| (Chen, 2009) | DEA with slacks | 7 hotels in Taiwan | (1) Number of employees; (2) surfaced area; (3) guest rooms; (4) operating expenses; (5) depreciation expenses | (1) Occupancy rate; (2) rate of guest satisfaction; (3) number of guests; (4) room revenue; (5) other revenue |
| (Assaf, et al., 2010) | DEA metafrontier | 78 Taiwanese hotels | (1) number of rooms; (2) number of full time equivalent employees in the room division; (3) number of full time equivalent employees in the food and beverage division; (4) number of full time equivalent employees in other departments. | (1) Total room Revenues; (2) total food and beverage revenues; (3) total of other revenues |

| | | | | |
|---|---|---|---|---|
| (Manasakis, Apostolakis, & Datseris, 2013) | DEA | 50 superior hotels in Greece | (1) Number of employees; (2) number of beds (3) total operational cost | (1) Total revenue; (2) total number of nights spent |

Studies incorporating environmental concerns on firms' operations overwhelmingly focus on the manufacturing sector in the past. The service sector firms which are the "silent destroyers of the environment" got attention of researchers in recent years (Shieh, 2012). The study by Bohdanowicz (2006) for Swedish and Polish hotel industries reveal that the magnitude of the impacts of the hotel industry is often underestimated and that it consumes a vast amount of local and imported non-durable goods, water and energy, and it emits large amounts of carbon dioxide. Although individual hotels may not have a significant negative impact on the environment, collectively they can consume a huge amount of resources and be very wasteful. It has been estimated that 75% of hotels' environmental impacts can be directly related to excessive consumption (Bohdanowicz, 2006). This is wasteful in terms of resources and it creates unnecessary operational costs. As a result hotels increasingly adopt green practices to their production processes.

Measuring the impact of eco-friendly or green practices on hotel efficiency could be an interesting research area in efficiency studies. The *Green Hotels Association* (2014) articulates the concept of a green hotel as "environmentally-friendly properties whose managers are eager to institute programs that save water, save energy and reduce solid waste—while saving money—to help protect our one and only earth!". Such practices can have an impact on the overall efficiency of decision making units. This paper aims to identify the impact of green practices on the overall efficiency of firms.

Initial ideas of using green practices in hotel management around the world were centred on cost saving initiatives by reducing waste and energy usage and government regulations (Shieh, 2012). However, due to the escalating demand for green hotels, adopting green practices is not only a cost saving method but is also associated with customer expectations (Chan, 2013; Manaktola & Jauhari, 2007), corporate image (Penny, 2007) and the willingness to pay a premium for green hotels (Kang, Stein, Heo, & Lee, 2012; Laroche, Bergeron, & Barbaro-Forleo, 2001). Since implementing strategies related to *green* management of a hotel is difficult, hotel managers need to know what actually drives a hotel’s efficiency and hence, profitability. Although managerial implications of using green practices in hotels are examined, the efficiency of hotels adopting green practices is yet to be investigated. Moreover, empirical testing of the relationship between green practices and technical efficiency becomes an important and timely concern in a context such as Sri Lanka where environmentalism is increasingly being promoted by the government.

## 4. Methodology

DEA is a linear programming procedure for a frontier analysis of inputs and outputs. It was first introduced by Charnes, Cooper, and Rhodes (1978), built on the frontier efficiency concept first elucidated in Farrell (1957), as a mathematical programming approach to the construction of production frontiers and as a measure of efficiency in relation to the estimated frontiers. This model which assumes constant returns to scale is also known as CCR model. Banker, Charnes, and Cooper (1984) first introduced the assumption of variable returns to scale. This model is known as BCC in literature. The use of this model permits the calculation of pure technical efficiency (PTE) and scale efficiency (SE).

DEA is applied to unit assessment of homogeneous units, such as hotels, which are referred to as decision-making units (DMU). The efficiency of a DMU is measured as the ratio of weighted outputs to weighted inputs. The efficiency of each DMU could be calculated, once the frontier is constructed, by comparing distances from the points on the frontier with the points that are below the frontier. However, DEA is sensitive to outliers which might exaggerate the actual frontier. The researcher must specify three characteristics of the model: the input-output orientation system, the returns to scale and the weights of the evaluation system in order to solve the linear programming problem. DEA could be used to decompose overall efficiency into technical and allocative efficiencies, and further allows the decomposition of overall technical efficiency (OTE) into pure technical efficiency (PTE) and scale efficiency (SE).

The output-oriented DEA efficiency estimator $\widehat{\delta_\iota}$ can be derived by solving the following linear programming;

$$\widehat{\delta_\iota} = \max_{\widehat{\delta_\iota},\lambda}\left\{\delta > 0 \middle| \widehat{\delta_\iota} \leq \sum_{i=1}^{n} y_i\lambda; x_i \geq \sum_{i=1}^{n} x_i\lambda; \lambda \geq 0\right\}, \textit{ i=1....n firms} \quad (1)$$

where $y_i$ is avector of outputs, $x_i$ is vector of inputs, λ is a I ×1 vector of constants. The value of $\widehat{\delta_\iota}$ obtained is the technical efficiency score for the i-th hotel. A measure of $\widehat{\delta_\iota} = 1$ indicated that the hotel is technically efficient, and inefficient if $\widehat{\delta_\iota} < 1$. This linear programming problem must be solved n times, once for each hotel in the sample.

Note that the DEA model described above is a constant returns to scale (CRS) model. We impose a variable returns to scale (VRS) assumption on the above model by introducing the constraint $\sum_{i=1}^{n} \lambda = 1$.

The efficiency scores ranging between 0 and 1 define a ranking for the hotel such that 1 corresponds to the most efficient hotels and 0 indicates the least efficient. A DMU with a score less than 1 is relatively inefficient compared to the best performing DMU. Scale efficiency is obtained by taking the ratio between CRS and VRS.

In order to test the hypotheses that efficiency of hotels is determined by different contextual variables, this study uses the two-step approach as suggested by Coelli, et al. (1998). It is argued and recognized in DEA literature that the efficiency scores obtained in the first stage could be correlated with the explanatory variables used in the second stage regression. This could lead to inconsistency and bias estimates of the second stage regression. To overcome this problem, bootstrap procedure is needed as pointed out by Simar and Wilson (2007). The bootstrap is a resampling technique used as a means of approximating the properties of the sampling distribution of an estimator and, hence, allowing to conduct hypothesis testing and construct confidence intervals. We estimate the following specification;

$$\widehat{\delta_\iota} = z_i\beta + \varepsilon_i \quad (2)$$

Where $z_i$ is a vector of environmental variables which is expected to explain the efficiency variations, β refers to a vector of parameters to be estimated and $\varepsilon_i$ is an error term.

In hotel efficiency literature, the bootstrapping method was first used by Barros and Dieke (2008), who estimate technical efficiency of 12 hotels in Africa over the years 2000-2006. In the first stage they use a DEA model to rank hotels and in the second stage, the Simar and Wilson (2007) procedure is used to double bootstrap DEA scores with a truncated regression. Assaf and Agbola (2011) employ double bootstrap approach to assess the technical efficiency of Australian hotels for the period 2004–2007. These studies indicate that the DEA bootstrap approach corrects for the bias inherent in traditional DEA models.

## 5. Data and results

### 5.1 Data

We use panel data for 24 hotels over the period of five years (2010-2014). The data is obtained from a field survey undertaken in Sri Lanka in November 2014 to May 2015. The target population for this study is medium and large scale hotel establishments located in Sri Lanka. The number of DMUs which falls into this category is relatively low in a small developing economy like Sri Lanka. Although the current boom in the tourism industry give rise to massive investments in the hotel sector, medium and large scale hotels which were in operation for 5 years are limited. These factors contribute to explain the size of the population under investigation: currently there are 44 three to five star hotels (Sri Lanka Tourism Development Authority, 2013), hence a sample of 24 represents more than 50% of total population of interest.

DEA methodology can be applied to small DMU population (Evanoff & Israilevich, 1991; Perrigot, Cliquet, & Piot-Lepetit, 2009). For example, Chen (2009) uses DEA to investigate the efficiency of seven hotel chains in Thailand whereas Perrigot, et al. (2009) assess the efficiency of fifteen hotel chains in France. However, the number of inputs and outputs entered in the DEA model must be reasonable defined. The DEA literature suggests that number of DMUs should be at least twice the product of the number of inputs and outputs in the model (Dyson et al., 2001). Moreover, the bootstrap technique comes in handy especially in small sample situations hence provide reliable results (Atkinson & Wilson, 1995).

We measure output by 2 indicators; room revenue and other revenue (includes food and beverage revenue and revenue from other departments). We measure inputs by 3 indicators;

number of rooms, number of employees and book value of assets. The chosen inputs and outputs are based on two criteria; firstly the availability of data and secondly literature review of previous studies. Table 2 shows the summary statistics for the input and output variables used in the models.

**Table 2: Characteristics of the inputs and outputs[a]**

| Variables | Units | Range | Mean | SD |
|---|---|---|---|---|
| Outputs | | | | |
| Room revenue | LKR | 20-552.42 | 200.77 | 121.69 |
| Other revenues | LKR | 18-589 | 164.81 | 114.40 |
| Inputs | | | | |
| Number of employees | Number | 42-416 | 209.72 | 95.62 |
| Number of rooms | Number | 31-200 | 101.43 | 41.00 |
| Book value of assets | LKR | 32.18- 5766 | 987.26[1] | 1068.06 |

Note: LKR: Sri Lankan rupees; [a] the monetary values are in millions LKR

### 5.2 Results and discussion

We estimate DEA technical efficiency scores using output-orientation with the assumption that most hotels aim to maximize outputs given the inputs. Table 3 presents technical efficiency scores together with the average CRS and VRS scores. The average technical efficiency under CRS is 80.8% and under VRS it is 85.2%. Scale efficiency is high with an average of 95%.

This study further investigates the status of returns to scale for DMUs. From Table 3 and 4, approximately 33% of the hotels are constant returns to scale (CRS). Nearly 50% of the hotels operate at decreasing returns to scale (DRS). The rest operates at increasing returns to scale (IRS). This result implies that Sri Lankan hotels are facing a highly competitive environment (also see, Yang & Wen-Min, 2006). Considering the boom in the tourism industry in Sri Lanka, many hotels are concerned about physical expansion in anticipation of the large numbers of projected arrivals, rather than maximising operational efficiency. Physical expansion includes increasing the number of rooms and other areas within a hotel. However, tourism industry experiences seasonal fluctuations of tourist arrivals meaning the occupancy rate is low offseason. As a result, hotels as well as other accommodation providers compete for a limited number of foreign tourists. The above reasons may have made most hotels operate at DRS.

Table 3 further reports the average technical efficiency estimates for the hotels obtained from 2500 bootstrap iterations. We observe that the average bias-corrected technical efficiency is 70.5% with the maximum being 96.4% and the minimum is 43.6%. The results reveal that that the technical efficiency scores obtained from the traditional DEA model are higher than that of the DEA double bootstrap model. This demonstrates that the DEA double bootstrap model corrects for the bias in the efficiency scores; therefore it is more robust than the traditional DEA model in estimating the technical efficiency scores.

Table 4 indicates the summary information on the number and % of efficient and inefficient hotels. 45.8% of units present best efficient practices and the rest presents inefficient or less efficient practices.

**Table 3: Average technical efficiency scores for Sri Lankan hotels 2000-2014**

| Hotel | Traditional DEA Technical efficiency CRS | Technical efficiency VRS | Scale efficiency | Returns to scale | Bias-corrected technical efficiency |
|---|---|---|---|---|---|
| hotel01 | 0.880 | 0.889 | 0.990 | DRS | 0.7996 |
| hotel02 | 1.000 | 1.000 | 1.000 | CRS | 0.7892 |
| hotel03 | 1.000 | 1.000 | 1.000 | CRS | 0.9158 |
| hotel04 | 1.000 | 1.000 | 1.000 | CRS | 0.7467 |
| hotel05 | 1.000 | 1.000 | 1.000 | CRS | 0.7887 |
| hotel06 | 1.000 | 1.000 | 1.000 | CRS | 0.9636 |
| hotel07 | 0.592 | 0.603 | 0.982 | IRS | 0.4833 |
| hotel08 | 0.535 | 0.549 | 0.975 | IRS | 0.4363 |
| hotel09 | 0.824 | 0.861 | 0.957 | IRS | 0.7596 |
| hotel10 | 0.568 | 0.580 | 0.979 | DRS | 0.4695 |
| hotel11 | 0.559 | 0.612 | 0.913 | DRS | 0.5173 |
| hotel12 | 0.652 | 1.000 | 0.652 | IRS | 0.6990 |
| hotel13 | 1.000 | 1.000 | 1.000 | CRS | 0.7388 |
| hotel14 | 0.963 | 1.000 | 0.963 | DRS | 0.8176 |
| hotel15 | 1.000 | 1.000 | 1.000 | CRS | 0.7332 |
| hotel16 | 0.767 | 0.879 | 0.872 | DRS | 0.7704 |
| hotel17 | 0.711 | 0.861 | 0.826 | DRS | 0.7881 |
| hotel18 | 0.725 | 0.870 | 0.834 | DRS | 0.7514 |
| hotel19 | 0.995 | 1.000 | 0.996 | DRS | 0.8295 |
| hotel20 | 0.793 | 0.812 | 0.976 | DRS | 0.6557 |
| hotel21 | 1.000 | 1.000 | 1.000 | CRS | 0.8845 |
| hotel22 | 0.542 | 0.606 | 0.894 | DRS | 0.5399 |
| hotel23 | 0.671 | 0.685 | 0.979 | DRS | 0.5487 |
| hotel24 | 0.614 | 0.632 | 0.972 | DRS | 0.5034 |
| **Mean** | **0.808** | **0.852** | **0.948** | | **0.7054** |

**Table 4: Summary information of DMUs (2000-2014)**[2]

| Efficiency scores/ returns to scale | number of hotels | % of hotels |
|---|---|---|
| 1 | 11 | 45.8 |
| 0.99-0.80 | 06 | 25 |
| 0.79-0.60 | 05 | 20.8 |
| 0.59-0.40 | 02 | 8.3 |
| 0.39-0.20 | 00 | 0 |
| 0.19-0.00 | 00 | 0 |
| CRS | 08 | 33.3 |
| IRS | 04 | 16.7 |
| DRS | 12 | 50 |

[2] This is based on tradition DEA technical efficiency VRS efficiency scores

Next, we examine the determinants of technical efficiency of Sri Lankan hotels. The model is specified as follows:

$$\hat{\delta_\iota} = \beta_0 + \beta_1 age + \beta_2 star + \beta_3 size + \beta_4 type + \ \beta_5 eco + \varepsilon_i \qquad (3)$$

where δ represents technical efficient score. *Age* is the number of years the hotel was in operation, *size* is a dummy variable representing 1 for large hotels (more than 100 rooms) and 0 otherwise, *star* is the star rating of the hotel, *type* is a dummy variable which is 1 for resorts and 0 otherwise, aiming to capture the impact of the type of hotel on efficiency. Finally *eco* is a score given to each hotel based on their involvement in eco-friendly practices in their day to day operations. We took four areas into consideration; hotel's energy consumption, water consumption, waste management and other practices (each component equally weighted). Table 6 presents the criteria evaluated when constructing the *eco* variable.

The truncated regression model with a bootstrap fits the data well, with statistical significance for all parameters (except *star*) (table 5). Most estimations generally confirm our prior expectations. Table 6 reports the estimated truncated second stage regression results as specified in equation (3). The bootstrap confidence intervals obtained from running the double bootstrap are compared with the OLS and Tobit regression. We find that *age* coefficient is positive and statistically significant in influencing technical efficiency. This is consistent with prior research. The literature suggests that as hotels mature in age, they tend to earn a certain level of reputation and brand status which induces them to maintain a high level of efficiency in their operations (see for example, Assaf & Agbola, 2011; Shang, et al., 2009).

Higher star rating  often associates with higher efficiency (Assaf, Barros, & Josiassen, 2012; Assaf & Agbola, 2011; Barros & Dieke, 2008). However, the *star* variable was not found significant in any of the models in this study.

**Table 5: Determinants of efficiency**

| Variable | DEA truncated bootstrapped second-stage regression | | | | Bootstrap truncated regression results[1] | | |
|---|---|---|---|---|---|---|---|
| | OLS | | Tobit | | | | |
| | Coefficient | t-ratio | Coefficient | t-ratio | Coefficient | Lower bound | Upper bound |
| Constant | -0.2908 | -1.50 | -0.3363 | -1.95* | 3.791*** | 3.417 | 4.557 |
| Age | 0.0086 | 2.70** | 0.0091 | 3.26*** | -0.021*** | -0.030 | -0.019 |
| Star | 0.0107 | 0.24 | 0.0114 | 0.29 | 0.046 | -0.015 | 0.092 |
| Size | 0.1401 | 2.03* | 0.1525 | 2.51** | -0.218*** | -0.324 | -0.046 |
| Type | 0.4832 | 3.20*** | 0.4987 | 3.78*** | -1.437** | -1.726 | -0.352 |
| Eco | 0.0099 | 4.00*** | 0.0102 | 4.71*** | -0.029*** | -0.036 | -0.020 |
| Sigma | | | | | 0.088 | 0.119 | 0.172 |

** and *** indicate statistical significance at 5% and 1% levels respectively.

[1]total number of iterations= 2500.  A negative sign of the parameters mean that the associated variable has a positive effect on technical efficiency, and vice versa

Size variable is found to be positive and significant relationship with technical efficiency in all models. This is a dummy variable indicating 1 for large (more than 100 rooms) and 0 otherwise. The relationship between size and efficiency is an area of contradiction in the hotel efficiency literature. For example, Chen (2007) and Hwang and Chang (2003) indicates that no difference in efficiency exists between large and small scale hotels. However, Barros and Dieke (2008) finds that large hotels are more efficient that small hotels in their study for Africa (Luanda) and the same is found true for some studies on Portuguese hotels (Barros, 2005c, 2006). This study confirms the latter.

*Type* variable is found to have a positive relationship with efficiency. This means resorts are more efficient than city hotels. Literature provides mixed results; for example Tsaur, Chiang, and Chang (1999) finds that city hotels are more efficient than resorts whereas Wang, Hung, and Shang (2006) concludes that managerial efficiency of resorts is greater than that of city hotels.

Adopting eco-friendly or green practices contributes positively to the efficiency. The *eco* coefficient is positive and highly significant. This result confirms our prior hypothesis. Although initial adaptation of green practices may incur substantive costs, in the long run a hotel largely benefits in terms of costs by reducing the amount of water and energy used and more importantly, by establishing a brand image to attract more environmentally conscious customers.

**Table 6: construction of the *eco* variable**[3]

| Type of green practice | criteria |
|---|---|
| Energy | The hotel's use of renewable energy, as a % of total energy used (e.g. solar, biomass, wind)<br>The hotel's implementation of energy saving measures through energy efficient lighting and HVAC (heating, ventilation, and air conditioning) improvements |
| Water | The hotel harvests and utilises rainwater for purposes such as gardening and washing<br>The hotel controls the quality and quantity of effluent discharge with proper treatment prior to discharge into the environment and sewerage network |
| Waste | The hotel attempts to reduce generation of waste in its daily operations (e.g. such as by reducing the usage of paper, plastic and glass containers, food waste & used oil, cardboard and paper etc.)<br>The hotel reuses where possible<br>The hotel recycles waste (in the hotel and/or through external parties)<br>The hotel treats hazardous waste before sending to landfill |
| Other | The hotel serves and purchases locally-grown food (fruits and vegetables)<br>The percentage of the non-smoking environment of the hotel |

Finally, we regress efficiency scores obtained from the traditional DEA model against the environmental variables specified in equation (3). The results are provided in appendix 1. The variables maintain their signs in all models thus we conclude that results presented in table 5 are intuitive and quite robust.

## 6. Concluding remarks

This paper measures the technical efficiency of a sample of medium and large scale hotels in Sri Lanka. It was noted that Sri Lanka is one of the important tourist destinations in Asia which is experiencing a post war tourism boom thus a performance evaluation of the hotel industry is found necessary for the development of the tourism industry. By applying the non-

[3] The questions are based on a previous survey conducted in Sri Lanka by Green Hotels Association (2014)

parametric approach DEA, we estimate the output oriented technical efficiency for the period 2010-2014 of a sample of 24 hotels considering CRS and VRS models. This study also uses DEA double bootstrap method as it corrects for bias in the estimation of technical efficiency. Overall, the average technical efficiency score (bias-corrected) of Sri Lankan hotels is found to be 70.54% for the study period.

In the second stage, we investigate the determinants of efficiency. We found that the hotel's age and size have a positive relationship with efficiency. The results suggest that hotels gain from the existence of economies of scale derived from the larger average size of the establishment. Resorts are found to be more efficient than city hotels, meaning the location play a key role in demand attraction and hence, contribute to higher efficiency. More importantly, we investigate that going green has a positive impact on improving technical efficiency of hotels. The criteria of measuring green practices included energy and water consumption, waste management and other operational practices. Therefore, hotels environmental initiatives help to improve their competitiveness save money and attract environmentally concerned customers.

As far as the individual hotels are concerned managerial implications for increasing efficiency indicate towards maximising total revenue of hotels. At a strategic level, hotels need to learn that maturity in terms of age and size helps to improve levels of efficiency (exploitation of economies of scale). From a national perspective, the results are important to confirm the government initiatives of adopting environmentally sustainable practices for hotels are essentially beneficial.

Although this research provides interesting insights for the development of the hotel industry, it is important identify its limitations. Firstly, due to data limitations, the number of DMUs used in this study was small. As a result we could not use too many input/output factors in the performance evaluation. Secondly, it would be interesting to include variables such as tourist satisfaction (Hathroubi, et al., 2014) or service quality to undertake a more comprehensive analysis. Thirdly, the sample used for the analysis is taken from Sri Lanka thus the generalisability of the results remains to be tested. Future research could take the above in to consideration.

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# Appendix 1

## Table 7: Traditional DEA second stage regression

| second-stage regression | | | | |
|---|---|---|---|---|
| Variable | OLS | | Tobit | |
| | Coefficient | t-ratio | Coefficient | t-ratio |
| Constant | -0.1035 | -0.37 | -0.1618 | -0.64 |
| Age | 0.0087 | 1.88* | 0.0094 | 2.31** |
| Star | 0.0019 | 0.03 | 0.0029 | 0.05 |
| Size | 0.0946 | 0.94 | 0.1103 | 1.24 |
| Type | 0.4238 | 1.92* | 0.4435 | 2.30** |
| Eco | 0.0100 | 2.77** | 0.0104 | 3.28*** |